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Mobile Robotic Platform: Autonomous Navigation

Robert Bell-Isle
University of Southern Maine, robert.belleisle@maine.edu

Tyler Werner
University of Southern Maine

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By: Robert Belle-Isle & Tyler Werner Under Supervision of Dr. Carlos Luck
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Updated System

By reworking the robotic platform from the ground up, a new operating system was designed. This new system, shown in Figure 3, includes a sleeker design and simplified user control. One of the core changes to this design is the inclusion of an onboard Raspberry Pi. The Pi is capable of creating its own local connection which removes the need for an internet connection. To create a more simplified startup procedure and lessen the burden of future updates, this system has been made to work alongside ROS. Now, the user needs only to run a single command line on a remote computer, connected to the PI, to initiate control.

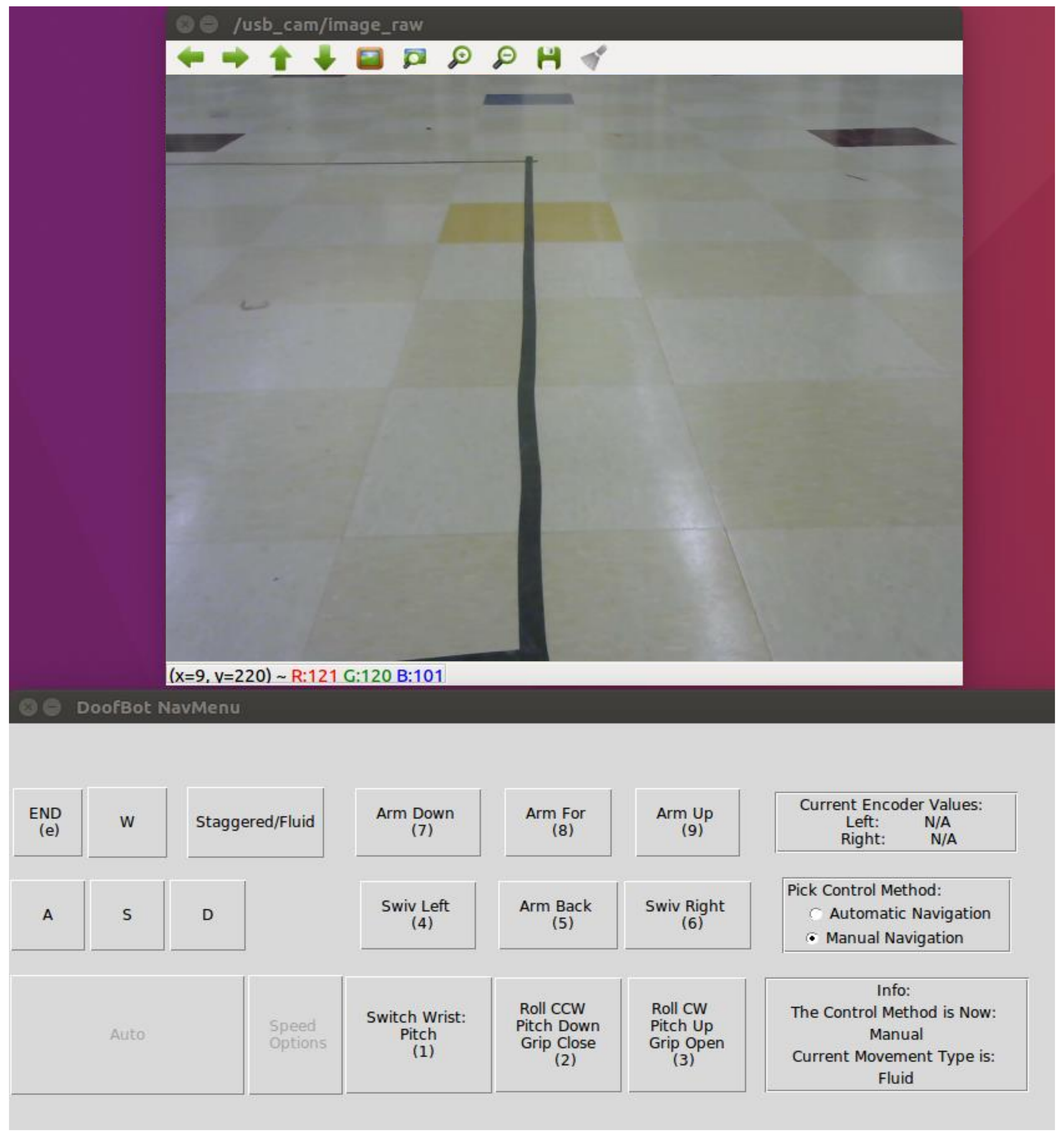


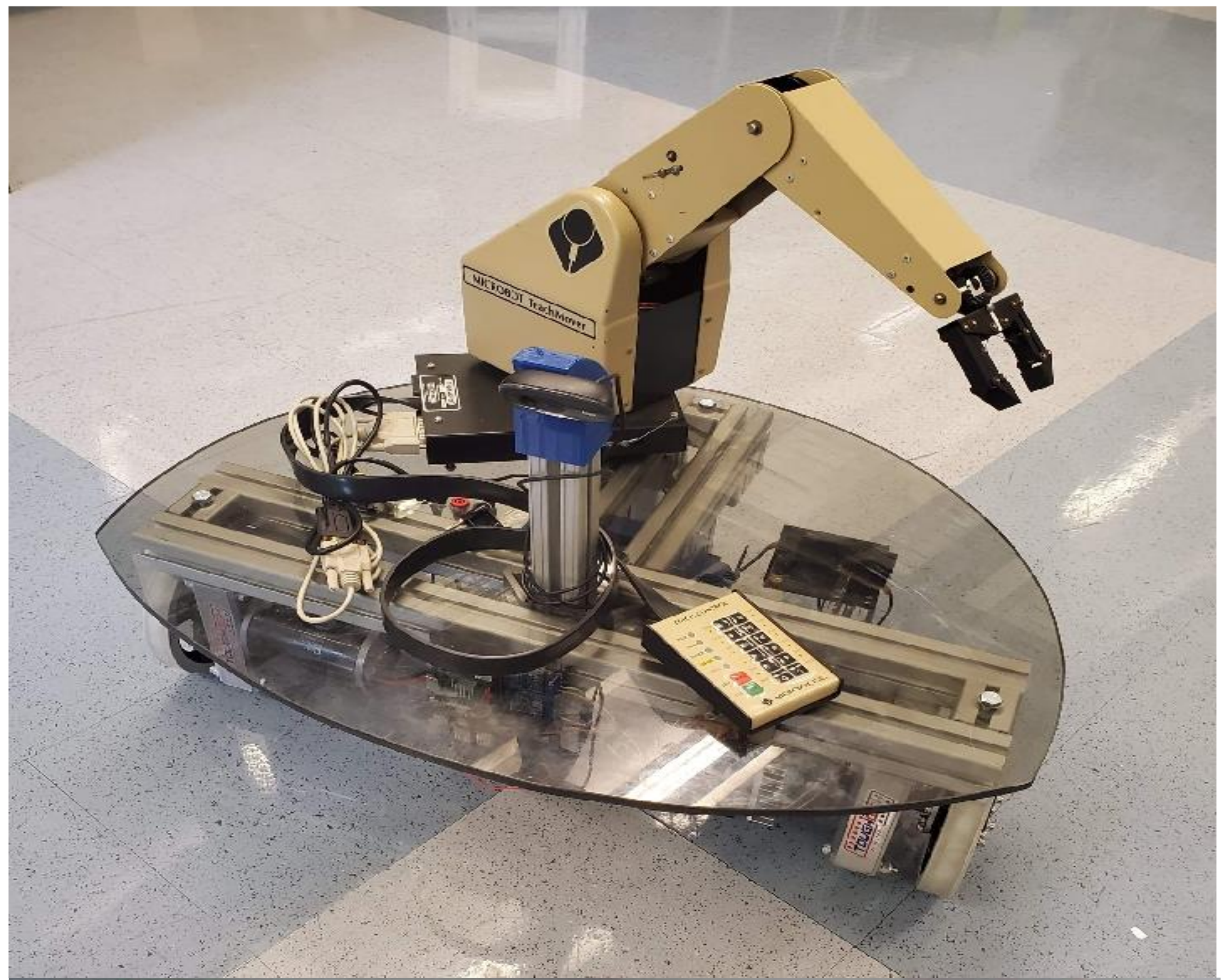
Figure 3: Updated GUI: Includes New Live Streaming and Button Control

PID Control

PID (Proportional-Integral-Derivative) controllers dictate the output of a system to achieve a desired input. This PID controller used in this design works alongside both ROS and the motion planning software. The controller receives inputs of distance, in feet, and executes these commands while balancing the speed of both wheels.

Abstract

Robotics is a fairly new scientific branch, however it has advanced tremendously in a short amount of time. This is reflected by the progression of the Mobile Robotic Platform project that has spanned the last decade at USM. The additions to this ongoing project include: a redesign of the mobile robot shown in Figure 1, updates to the code to increase simplicity, and motion planning software to enable autonomous navigation. The design utilizes an onboard Raspberry Pi 3, shown in Figure 2, which communicates wirelessly with a host computer through ROS (Robotic Operating System). A motion planning process that utilizes an A* heuristic search algorithm and integrates computer vision for obstacle avoidance was also added. Finally, this system was designed to accommodate any user, regardless of experience, including future students who will build upon this project.



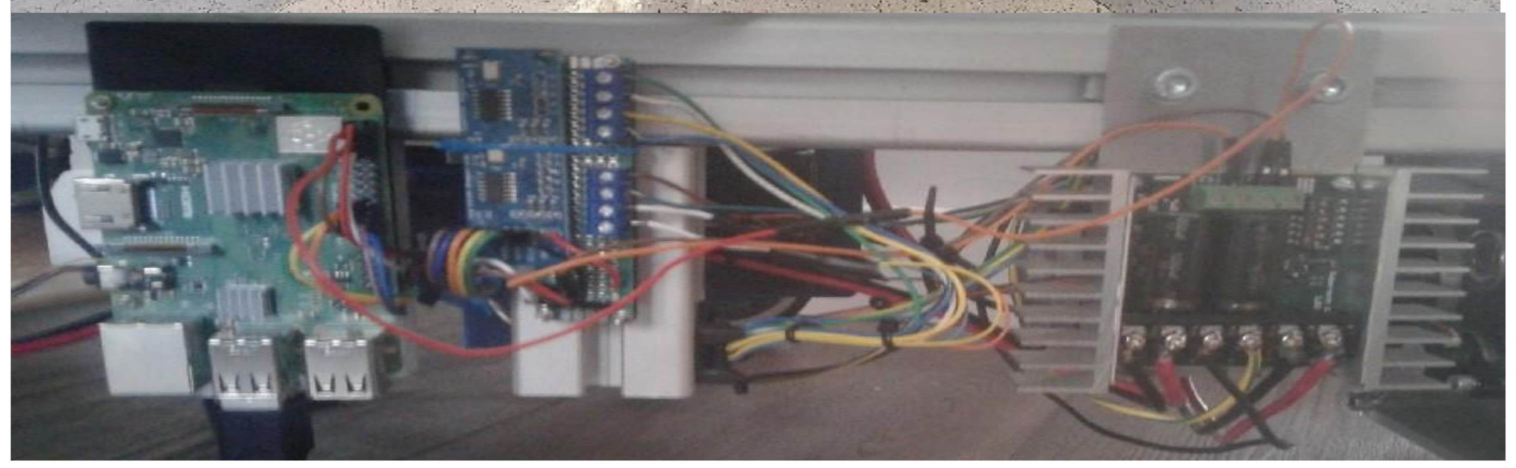


Figure 1 (Top): Image of Mobile Robotic Platform.
Figure 2 (Bottom): Electronic Hardware including the Raspberry Pi (left).

Image Processing

OpenCV, an image processing library, is used by the robot to identify unknown objects. By taking photos of the space in front of the robot, OpenCV is able to determine both its current location and any objects in that space. An example of processing and image of a tiled floor to calculate location is shown in Figure 4. Comparing this location with the current mapping software, the system is updates the map with any obstacles that were preciously unknown.

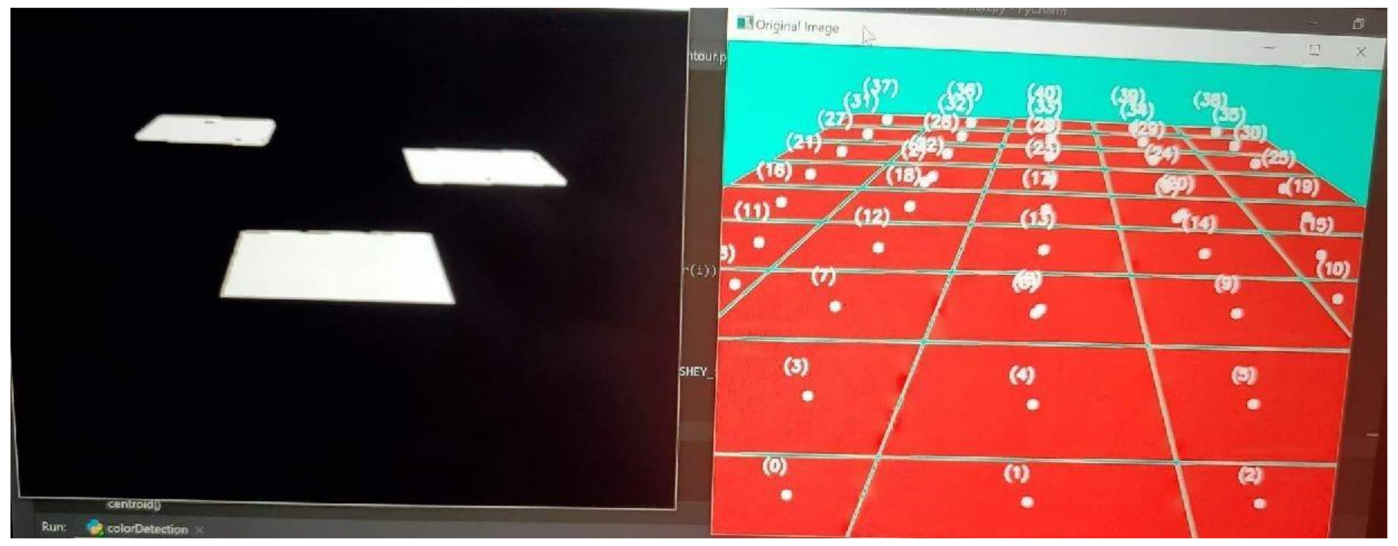


Figure 4: Image Processing Using OpenCV

Motion Planning

The robot utilizes a heuristic A* search algorithm to plan paths in mapped areas, known as the workspace, that contain unknown obstacles. An example of this robots workspace is shown in Figure 5. The A* search algorithm tends to take longer as the map size grows larger. However, given current path generation options available, this algorithm was determined to be the best option for the robot due to simplicity.

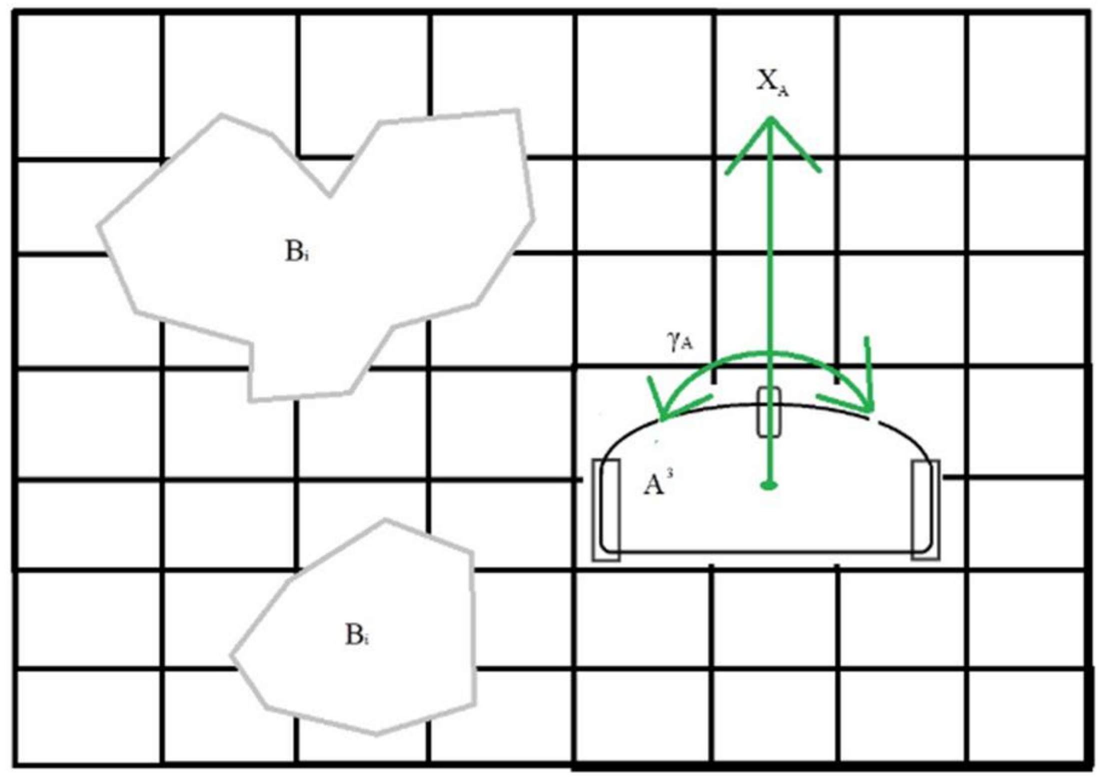


Figure 5: Workspace and Movement Capabilities of Robot